TAXONOMIC REVIEW OF THE *VARANUS PRASINUS* GROUP WITH DESCRIPTIONS OF TWO NEW SPECIES

ROBERT GEORGE SPRACKLAND

Sprackland, R.G. 1991 08 01: Taxonomic review of the *Varanus prasinus* group with descriptions of two new species. *Memoirs of the Queensland Museum* 30(3): 561–576. Brisbane. ISSN 0079-8835.

Examination of seven character systems, including skull morphology, scalation, external morphology, colour pattern, ecology, karyotype, and behaviour, provide the data for taxonomic rearrangement. The subspecies *Varanus prasinus kordensis* is placed in junior synonomy with *V. prasinus*, while the subspecies *V. p. bogerti* and *V. p. beccarii* are elevated to specific status. In addition, two new extralimital species are described, *V. teriae*, sp. nov., from Australia's Cape York Peninsula, and *V. telenesetes* sp. nov., from Rossell Island, Papua New Guinea. A model for tree monitor origin and dispersal is presented. The group is probably derived from Varanus indicus stock, having primarily invaded New Guinea and extended later into northeastern Australia. □*Varanus, taxonomy, zoogeography, cladistics.*

Robert George Sprackland, Department of Zoology, University of Idaho, Moscow, Idaho 83843, USA; Present address: Associate Curator of Herpetology, San Jose State University, San Jose, California 95192, USA; 6 July, 1990.

Tree monitors are a closely allied group of medium sized lizards that range across the lowlands of New Guinea (Boulenger, 1885; De-Rooij, 1915; Mertens, 1942c, 1950, 1959; Allison, 1982) and northeastern Australia (Cogger, 1975; Czechura, 1980). They are characterized by elongated body and limbs, and a fully prehensile tail (Greene, 1986), that is at least 1.75 times snout-vent length. Most widespread of these lizards is the striking emerald, or green, tree monitor, *Varanus prasinus*. The adaptations for arboreality represent highly derived characters within the Varanidae (Greene, 1986).

Mertens (1942a, c) assigned *V. prasinus* to the subgenus *Odatria* primarily on the basis of its round tail, but acknowledged that *V. prasinus* was unlike other odatrians. Mertens (1941, 1942a,c, 1950) placed four subspecies under *V. prasinus: prasinus, kordensis, beccarii,* and *bogerti*. My examination of a number of varanid species, including several *Odatria* and *V. prasinus*, suggests that the *prasinus*-group is distinct enough in habits, ecology, and morphology to warrant separation from *Odatria*.

This paper reviews the tree monitors, and concludes that 1, two subspecies previously assigned to *V. prasinus* be elevated to specific status, 2, the subspecies *kordensis*, representing normal variation within *prasinus*, be placed in junior synonomy with *prasinus*, 3, Australian and Rossell Island lizards represent new species, and 4, the *prasinus* group is directly descended from *Varanus indicus*-related varanids and not from *Odatria*.

MATERIALS AND METHODS

Forty six specimens of the *V. prasinus*-group were examined for skull morphology, scalation, external morphology, colour-pattern, ecology, and behaviour. Live specimens of *V. prasinus* and *V. beccarii* were examined in zoos and private collections.

Fifty-seven derived traits were tabulated for 23 varanid species to determine relationships of the prasinus-group to the Varanidae in general (Appendices 1 and 2). A character was assigned ancestral (0) status if it was common in related, non-varanid outgroups (helodermids, lanthanotids, anguids) (Pregill et al., 1986). Thus, a round nostril condition, common to most lacertilians, is rated as ancestral, while a slit nostril is considered derived. McDowell and Bogert (1954) pointed out that in varanids, the elongation of the snout is a secondary (=derived) condition that preceded the forward placement of the nostrils. Consequently, an ancestral varanid is expected to have an elongated snout with a posterior nostril (0) (i.e. *V. griseus*). In non-varanid outgroups, the adpressed limbs do not meet, so this was taken as the ancestral condition. Other traits were assessed similarly.

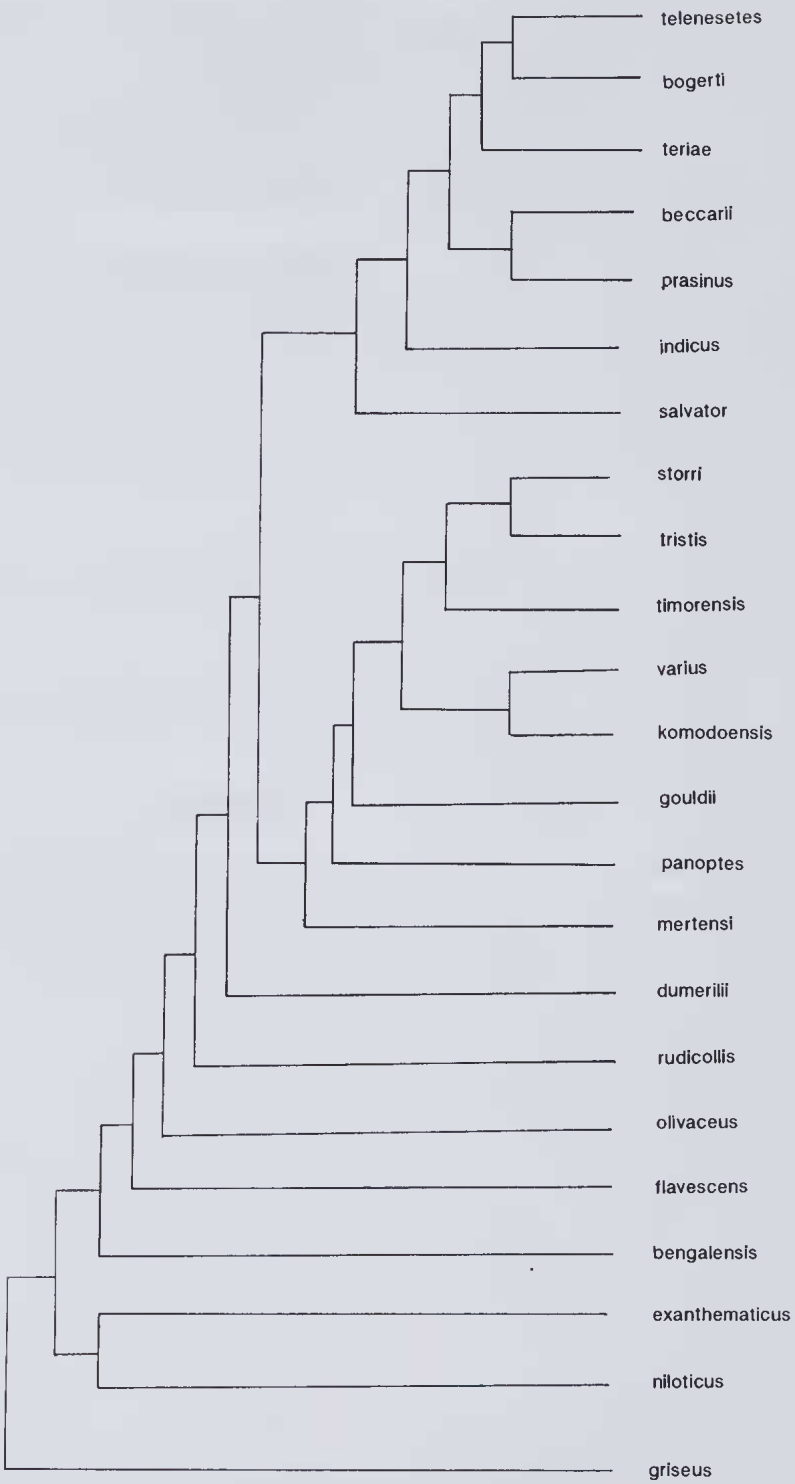

FIG. 1. PAUP produced cladogram for 23 varanids. Note that the geographic range for each taxon extends further east as one moves up the cladogram. Also note the implied relationship of the prasinoids (top 5 taxa) to both *V. indicus* and *V. salvator*. Character states and characters used given in Appendices 1 and 2.

Karyotype data were derived from Holmes et al. (1975), King and King (1975) and Auffenberg (1981, 1988). Hemipenal data are from Branch (1982) and Bohme (1988). Some information on cranial morphology was taken from Mertens (1942b). Other data were taken from specimens at the institutions listed below. The cladogram (Fig. 1) was constructed from the Phylogenetic Analysis Using Parsimony program (PAUP).

Specimens examined were from the American Museum of Natural History (AMNH), British Museum (Natural History) (BMNH), Field Museum of Natural History (FMNH), Florida State Museum (FSM), Queensland Museum (QM), United States National Museum of Natural History (USNM), University of Kansas Museum of Natural History (KU), California Academy of Sciences (CAS), Museum of Comparative Zoology (MCZ), Museum of Vertebrate Zoology (MVZ), University of Texas at Arlington (UTACV), San Jose State University Vertebrate Museum (SJSU), and the author's collection (RGS).

A brief description of certain character states employed (Appendix 1) is warranted:

4. The area surrounding the nostril is either raised, forming a distinct mound along the line of the canthus rostralis (1), or else the region is undifferentiated from the canthus.

8. The tongue is short (0) if it extends no greater than the distance from the snout tip to the posterior border of the eye.

10. The snout is considered broad at the tip (0) if there is minor constriction anterior to the eyes, that is, if the dorsal aspects of the canthus rostrali are nearly parallel.

12. A blunt snout (0) is taken to mean the line of the mouth is nearly parellel to the line of the canthus.

21. Cranial surface is a character of overall texture. A rough (0) surface has deep sutures between individual scales.

22. A rounded canthus is an indistinct morphological line (0); a distinct canthus is an acute line formed at the junction of the dorsal and lateral aspects of the region between the eye and the snout tip (1).

23. If the snout is triangular (1) in section, the lower borders of the maxillary bones are further apart than their upper borders.

28. Neck length is moderate (0) if it is less than or equal to the distance from snout tip to posterior border of the eye.

53. Reserved for unpublished data.

RESULTS

In the Australia–New Guinea region, two major lines diverged: 1, the primarily Australian monitors, characterized by small, pebbled cranial scales, comparatively short tails, and terrestrial habits, and 2, the Indo–New Guinean monitors that retain large, polygonal cranial scales, relatively long tails and arboreal/semiaquatic habits. In the first group have been placed two subgenera (Mertens, 1942c). *Varanus* includes *varius, komodoensis, gouldii, panoptes* and *mertensi* (and probably *rosenbergi,* which was unavailable for this study), all species >1m in TL. The other subgenus is *Odatria*, typically <1m TL, with round, keeled tails. Except for *Varanus (Odatria) timorensis,* the subgenus is endemic to Australia.

Varanus indicus was removed from Mertens' subgenus *Varanus* and assigned to the subgenus *Euprepiosaurus* (Bohme, 1988), to which *V. karlschmidti* may be added (pers. obs.). Bohme also placed *V. prasinus* in *Euprepiosaurus* while leaving *V. salvator* unassigned. Though this study has employed less than half the described varanid taxa, preliminary results seem to indicate that subgeneric destinction in *Varanus* may be an unwarranted artifact. Mertens (1942a, c) assigned the tree monitors to the subgenus *Odatria,* containing 'small species, under 1m long, with rather short snout (except in *prasinus,* where it is decidedly long), and moderately high head, the nostril round or oval, almost always nearer the tip of the snout than the eye and... the tail is not laterally compressed...; supraoculars not much differentiated, except in the *prasinus* group; ...most with mesoprosopic, except *prasinus*, which has hypsirosopic...maxilla; nasals paired (except for *prasinus*)' (Mertens, 1942c, p. 240). A mesoprosopic snout would be square in section; a hypsirosopic snout would be triangular in section, with a broad base and narrow dorsal aspect.

McDowell and Bogert (1954) also noted that the maxillary structure, which produces facial robustness in most odatrians, is nearly flat in *V. prasinus.* Mertens distinguished *prasinus* from other odatrians by four characters; snout length, maxillary configuration, supraocular structure, and condition of the nasal bones.

An examination of odatrian monitors and the *prasinus*-group reveals other morphological distinctions. Cranial lepidosis in *Odatria* is small, pebbled in texture, and nearly uniform in size over the frontal-parietal region. In *V. prasinus* and its allies, these individual scales are larger, flat, polygonal, glossy, and smooth (though the depth of suture lines between individual scales gives an overall rugose texture in some taxa).

The supraoculars are transversely enlarged, and quite distinct from the frontal-parietal scales. The labial scales in odatrians are small and indistinct; in *prasinus*, they are larger, and well defined. Mertens (1942c, p.291) noted these features, and concluded that '*prasinus* seems unrelated to any recent monitors, being similar to no other species.'

This study disputes Mertens' assertion, and suggests the *prasinus*-group are closely allied to *V. indicus*, and, less closely, to *V. salvator*. In contrast to *Odatria*, the southeast Asian varanids tend to be larger, with compressed, slightly keeled tails. The limbs are longer, slender, and terminate in elongated digits. Their habitats tend to be mesic or semi-aquatic. In morphology, they resemble *prasinus* in having similar cranial scalation, including flat, polygonal, glossy scales, and enlarged supraoculars. They also agree in having fused nasal bones, long snout, medial nostrils (*in indicus*) and flat maxillary region.

Comparing data from Bohme (1988) and 56 presence/absence characters, this study confirms the affinities between the *V. prasinus*-group (*prasinus, beccarii, bogerti, teriae* and *telenesetes*) and *V. indicus* (Fig. 1).

However, this study cannot assign the tree monitors to an existing subgenus. Though similarities with *V. indicus* are numerous, at least six differences are equally distinct. Erection of a subgenus for tree monitors would form a paraphyletic assemblage, leaving *indicus, salvator*, and, probably, *karlschmidti* and *salvadorii* as the artificial sister group.

Because the cladogram (Fig. 1) is based on a limited number of taxa and characters, it cannot represent a final picture of varanid phylogeny. Both the characters employed and the purpose of using PAUP were to help ascertain the relationships of the tree monitors to each other and, in a general sense, to other varanids. That five good tree monitor lineages exist is a warranted conclusion; that subgeneric criteria can, or should be established, is not. Consequently, I recommend against subgeneric assignations for *Varanus* on the grounds that 1, different studies tend to ally species differently, 2, most designated subgenera are monotypic, thus of no real value (e.g., they either represent valid genera or they tell us nothing of systematic importance), and 3, the frequent shifting of subgeneric content in the literature presents a confusing and, at this stage at least, pointless exercise.

SYSTEMATICS

Varanus prasinus Group

I suggest that the presently recognised subspecies be elevated to full specific status based on morphological distinctness and distribution. I follow Wiley (1981), seeing sympatry and hybridization as irrelevant to determining functional evolutionary entities. The absence of observable hybrids can be used to support specific designations, although admitedly this is an artificial criterion as hybrids are often phentotypically indistinct. Allopatry of these taxa has resulted in distinguishable characters and lineages, even among the patternless melanistic forms. Though many biologists resist descriptions based largely on colour and pattern, such obvious traits are important and have already been used to erect new species (Myers and Daly, 1976; Storr, 1980). The variation of hue and pattern in *V. prasinus* once used to separate two subspecies is widespread throughout the lizard's range, and represents dynamic variation within the taxon. Enough characters can be examined to show no distinction between *prasinus* and *kordensis*.

Diagnosis

Medium sized (to 1m total length), with (1) thin body, neck, limbs, digits and tail, (2) tail round in section, (3) tail fully prehensile, (4) nostril round or slightly oval, (5) nostril positioned midway between snout tip and orbit, (6) nasals fused, (7) premaxillary teeth 9, maxillary 10, dentary 11, (8) supraoculars transversely dilated, (9) preocular streak absent, (10) canthus rounded, (11) cranial scales large, polygonal, glossy, (12) maxillary region flat, not swollen, (13) snout triangular in sectional aspect, (14) preanal pores absent, and (15) tongue pink.

Characters 1, 2, 3, 4, 5, 9, 10, 13, and 14 are synapomorphic to tree monitors. Characters 2, 3, 5, 7, 9, 10 and 14 separate them from *V. komodoensis, gouldii, varius* and *salvator*. Characters 3, 5, 6, 7, 8, 9, 10, 11 and 12 separate them from *Odatria*. Though closely allied to *Euprepiosaurus* (Bohme, 1988), including *V. indicus* (Bohme, 1988) characters 1, 2, 3, 7, 9, and 15 distinguish tree monitors from the latter. They share character 15 with *V. karlschmidti* and subspecies presently assigned to *V. indicus* (e.g., *V. i. spinulosus* and *V. i. kalabeck*; Sprackland, in prep).

FIG. 2. *Varanus prasinus*, showing the banded (upper right and lower; author's collection) and rosette (upper left; Oklahoma City Zoo) dorsal patterns.

	telenesetes	*teriae*	*prasinus*	*bogerti*	*beccarii*
#ventrals	92	84–91	71–90	87–90	70–79
#midbody	100	90–93	80–112	95–99	81–86
#richtals	40	40	32–42	44–48	32–37
Nuchals	sl. keel	sl. keel	smooth/sl. keel	tubercular	keeled
Cranials	smooth	sl. rugose	smooth	rugose	sl. rugose
Gulars	flat	conical	flat	flat	flat
Palms	pale	black	black	black	black
Ventor	mottled	green	green	black	black
Dorsum	green	black	green	black	black
Pattern	yes	yes	yes	no	no
Ventrals	smooth	smooth	sl. keel	smooth	sl. keel

TABLE 1. Comparison of morphological features in tree monitors.

COMMENTS

Tree monitors are derived from the *V. salvator-indicus* lineage as evidenced primarily by cranial lepidosis and skull morphology. They are distinct in colour, habits, ecology and morphology warranting specific status (Fig 1). The green colour, prehensile tail and arboreal habit suggest this easternmost radiation is highly derived. Apparent lack of vagility in distribution of tree monitors, compared to the *indicus* or *salvator* groups, is assumed to reflect recency of evolution, though the group is moving from mainland New Guinea to islands and adjacent Australia.

Varanus prasinus (Schlegel, 1839)
(Figs 2,3)

Monitor viridis Gray, 1831:26.
Monitor prasinus Schlegel, 1839:78, tab.22, fig.5.
Hydrosaurus prasinus Schlegel; Gray, 1845:13. (Lizards Brit. Mus.)
Varanus prasinus Schlegel; Bleeker, 1856:278.(Reis Minahassa 1).
Monitor kordensis Meyer, 1874:131.
Odatria prasina (Schlegel); Günther, 1877:413. (Ann. Mag. Nat. Hist.19).
Varanus kordensis (Meyer); Boulenger 1885:322. (part)
Varanus kordensis (Meyer); De Rooij, 1915:152. (part)
Varanus prasinus prasinus Schlegel; Mertens, 1942c:292.
Varanus prasinus kordensis (Meyer); Mertens, 1942c:295.

MATERIAL EXAMINED

UTACV6736, 6744, 6816; FMNH14102, 14103; AMNH99610, 59051, 101071, 92335, 92337, 59053, 99611, 92371, 92663, 105877, 105878; MCZ149745, 149746, 141304, 140843, 126800, 126801, 137514, 4435, 137529, 137530, 10119, 126798; USNM195775 (3 sp); CAS135589, 126909, 20900, 126922; RGS100, 101; MVZ74904, 74905; plus 7 living animals.

DIAGNOSIS

Green, with black chevrons dorsally, unpatterned below. Nuchals round or oval, smooth or with slight keel.

Distinct from *beccarii, teriae* and *bogerti* on the basis of colour and smoother nuchals. It differs from *telenesetes* in having black, not pale, palmar surfaces, and in having an unpatterned ventral coloration. (Table 1).

DESCRIPTION

Snout long, depressed at tip. Canthus rostralis indistinct, swollen around nostrils. Nostrils round, median between orbit and snout tip. Upper labials flat, smooth and distinct, 22–23 in number. Cephalic scales large, polygonal, smooth or with minute pits. Sutures between cephalic scales shallow, giving a predominantly smooth texture. Supraoculars 3–7, transversely elongated. Scales from rictus to rictus 32–42. Nuchal scales are round or oval, anterior scales larger and smoother than posterior (though they occasionally shrink and become keeled from preservation). Posterior nuchals with single, posterior apical pit.

Dorsal scales slightly oval, becoming oval along sides, structure as posterior nuchals. Midbody scales in 80–112 rows. Ventral scales in

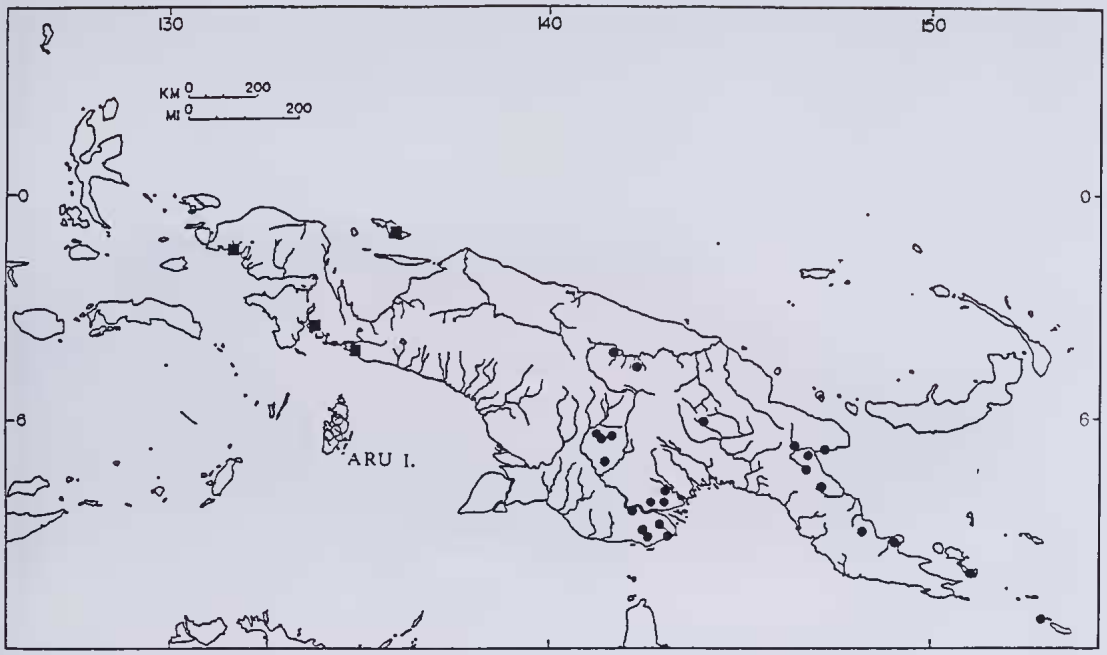

FIG. 3. Range map for *Varanus prasinus* (circles are localities examined by author; squares are localities from the literature) and *V. beccarii* (open circles) Aru Islands. Both taxa occur in lowland forests up to 500m.

71–90 rows, very feebly keeled, of *salvator*-type structure (Fig.10).

Adult SVL 125–290 mm (x=226.4). TL 463–874mm (x=653.7).

Scales green, ranging from dark jade to lime; labials often marked with black spots. Epidermis between scales velvet black, forming 6–8 crossbands in some individuals (Fig. 2 upper right and lower); these bands sometimes lacking; the green scales forming close-knit, indistinct concentric rings (Fig. 2 upper left); the latter, once assigned to the subspecies *kordensis* is found throughout the range of *prasinus,* and from the same sites as the banded morph; temporal streak absent; ventrally uniform green in color; throat yellowish, sometimes with greyish crossbands.

Distribution

New Guinea mainland, in lowland forests below 1,500 feet; absent from the mountains (Fig. 3).

Remarks

Monitor viridis was described by Gray (1831) based on a yellowish specimen without locality data. Schlegel (1839) examined a specimen from Fort de Bus on the western coast of New Guinea (=Irian Jaya) and renamed the species *Monitor prasinus.* Schlegel included a colour illustration of the lizard in the accompanying atlas. Because Gray's type was lost and the identity of *M. viridis* unconfirmed, *prasinus* took priority.

Meyer (1874) described *Monitor kordensis* from Wiak (=Kordo) Island, western New Guinea, based on its smaller dorsal scales, and a spotted, rather than banded, dorsum. DeRooij (1915) noted that the tail of *kordensis* was at least 2.33 times SVL, while it was under 1.75 times SVL in *prasinus.* Mertens (1941, 1942c) recognised these characters as distinguishing *kordensis* from *prasinus,* but concluded that they were conspecific. Mertens (1941) placed *kordensis* as a subspecies of *prasinus,* and maintained that position in a family review of varanids. His decision was based on only two animals and one skull of *kordensis* (Mertens, 1942c:295). Most characteristic of the differences between the taxa have been the keeled nature of the nuchals in *kordensis.* In living specimens of these lizards,

FIG. 4. Holotype of *Varanus telenesetes* sp. nov., QMJ1190, dorsal view of head.

the nuchals are smooth anteriorly, becoming oblong and keeled posteriorly. In specimens of *prasinus* (sensu Mertens, 1942c), preservation often causes a shrinking of these scales, making all nuchals appear oval and keeled. This character has not proved to be a reliable discriminant for either live or preserved tree monitors.

Boulenger (1885) noted that the body scales of *kordensis* are elongated, but observation also shows that the lateral body scales of *prasinus* are generally ovoid. Boulenger's description of *kordensis* is based on two specimens, one from Kordo (type locality), the other from 'New Guinea, South of Huon Gulf.' The latter is also described as 'entirely black.' I examined the latter specimen (BMNH76.7.6.2), and it proved to be *V. bogerti*. As a note of importance, Boulenger (1885) described *prasinus* as having caudal scales 'not keeled' and 'keeled' in the same paragraph, probably reflecting the variable effect of preservation on scutellation.

DeRooij (1915) described *kordensis* similarly to Boulenger, adding that the tail is 2.33 times SVL (vs 1.75 times SVL in *prasinus*). In measuring 40 lizards for this feature, no clear pattern was found in tail length/SVL ratio, either clinally from east to west, or by population within any given area. DeRooij also described *kordensis* as being either black or olive with dark crossbands. In listing the habitat, she indicated that the only specimens she examined personally were from the Aru Islands, which are now assigned to *V. beccarii*. The remaining localities given include much of New Guinea, and include, most likely, descriptions of *V. bogerti* and *V. prasinus* taken from other workers.

The most visible distinction between lizards dubbed *kordensis* and *prasinus* is colour pattern, which is what Meyer (1874) used as the principle justification for naming the new species. In the former, dorsal bands of green are formed from large occelli, giving the dorsum a spotted appearance unless the lizard is distended with air. *V. prasinus* is banded with green, occelli being distinguishable only in juveniles or along the spine. *V. kordensis* tends to be darker green (jade) than *prasinus* (lime). However, the geographical distribution of these patterns is random, showing no cline or population centres. The variation in colour and pattern may reflect

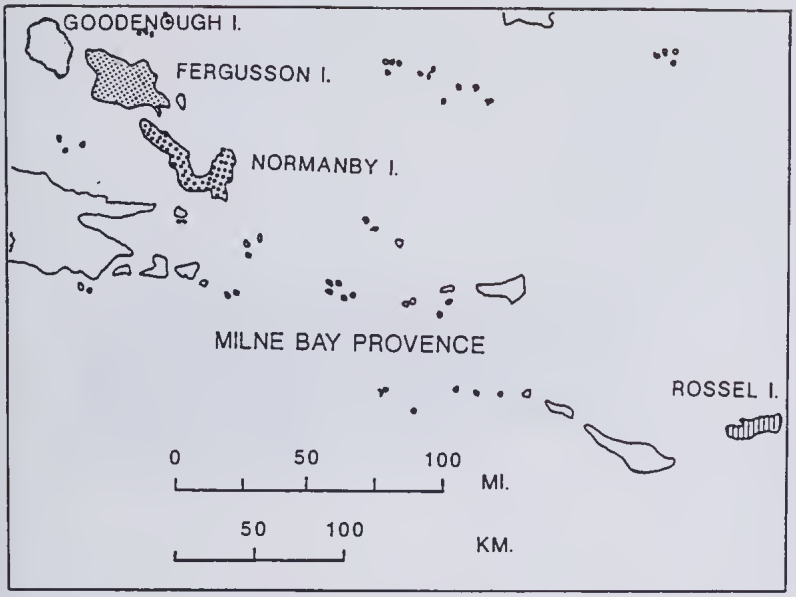

FIG. 5. Range map for *Varanus bogerti* (stippling) and *V. telenesetes* (lined).

allelic differences of a simple dominant/recessive pattern, but verification will require direct observation of known hybrids, suggesting the need for a longterm, captive breeding program. Given that the only difference separating these taxa is minor color variation, retention of *kordensis* as a subspecific entity is unwarranted.

Varanus telenesetes sp. nov.
(Figs 4,5)

1980 *Varanus prasinus* Czechura, p.103.

MATERIAL EXAMINED

HOLOTYPE: QMJ1190, Roussell (Rossel) Island, Milne Bay Province, Papua New Guinea.

DIAGNOSIS

Similar to *V. prasinus* from which it differs in having light, not black, palmar surfaces, smooth ventral scales, and a mottled ventral pattern. (Table 1).

DESCRIPTION

SVL 217 mm. TL 425 mm. Nuchal scales round, feebly keeled (possibly from preservation), equal in size to dorsals. Snout depressed, broad at tip. Nostril round, midway between orbit and snout tip. Upper labials 22, solid in color. Supraoculars enlarged, 7 in number. Scales across rictus 36. Tongue light in colour, probably yellowish in life. Cranial scales large, flat and smooth. Gular scales small, round, flat. Midbody scales in 100 rows. Ventrals in 92 rows, smooth. Palmar surfaces with conical pads, pale in colour. Claws short, compressed. Caudals feebly keeled. Adpressed limbs meet and overlap.

In colour, similar to *V. prasinus*, being green above, with indistinct dark chevrons, apices pointed posteriorly. Ventrally mottled cream and dark brown. Throat banded.

REMARKS

Mertens (1959) examined a varanid from Rossel Island which he assigned to *V. prasinus bogerti*, but the Queensland Museum specimen bears no resemblence to *bogerti*. Aside from the distinct colouration, the snout of *telenesetes* is broader and blunter than that of *bogerti*; *telenesetes* is further distinct from *bogerti* in having smooth cranial scales, fewer scales across the rictus (36 vs 44–48), feebly keeled (vs tubercular) nuchals, and feebly keeled (vs strongly keeled) dorsal scales.

Czechura (1980) discussed two monitors allied to *V. prasinus* but did not fit existing subspecific descriptions. They represent three specimens from Queensland (*V. teriae*), and a single specimen from Rossell Island, Papua New Guinea (*V. telenesetes*). *V. telenesetes* appears to represent a relict population that arrived on Rossel Island when there was a land link to mainland New Guinea, suggested by the zoned distribution of the tree monitors, and the lack of vagility demonstrated in their dispersal.

ETYMOLOGY

Greek *tele-*, far and *nesetes*, island dweller; refers to occurrence at the easternmost point of New Guinea, 330 km from the nearest tree monitor population.

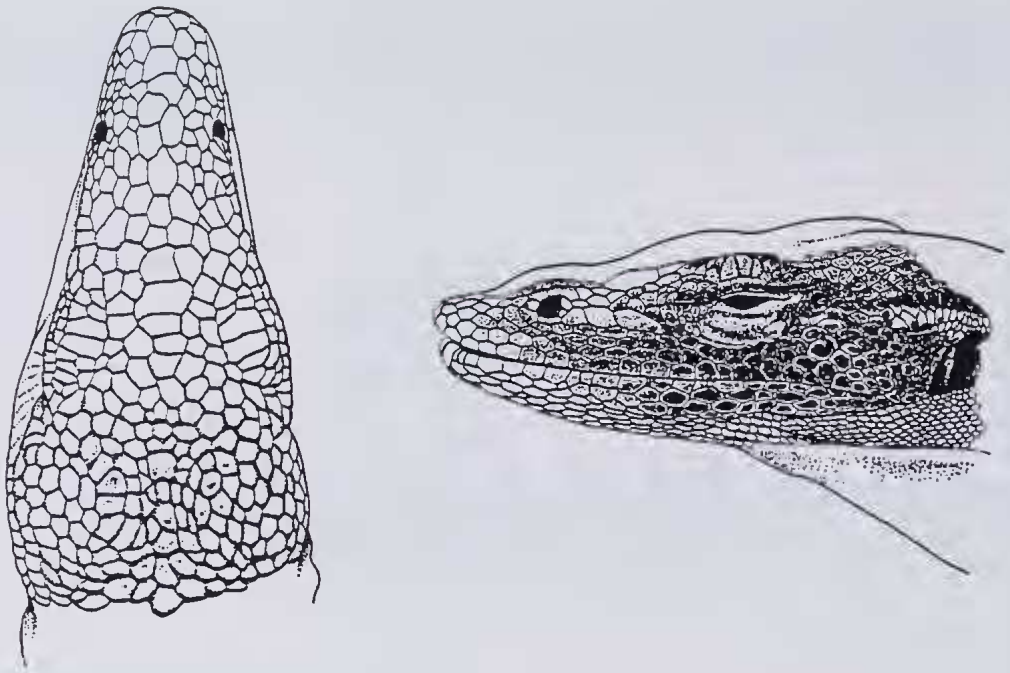

FIG. 6. *Varanus teriae* sp. nov., from the holotype. Drawn by Jeff Boundy from photograph by author.

Varanus teriae sp. nov.
(Figs 6,7; Table 2)

Varanus prasinus prasinus, Czechura, 1980 :103.

MATERIAL EXAMINED

HOLOTYPE: QMJ31566 from Buthen Buthen, Nesbit River, Cape York Peninsula, Queensland. Collected August 1978, by Gregory Czechura.

	QMJ31566 (H)	QMJ35450 (P)	QMJ35451 (P)
SVL	254	252	225
Tail	513	500	450
Snout–Orbit	21	22	19
Ventr Scale Rows	84	86	91
Midbody Scale Rows	93	90	90
Scales Across Richtus	36	36	36
Sex	M	M	F

TABLE 2. Measurements of the type series of *Varanus teriae* sp. nov.

PARATYPES: QMJ35450, 35451; same locality data as holotype.

DIAGNOSIS

A predominantly melanistic lizard, with light bluish-green snout tip, yellow dorsal spots forming thin, paired chevrons and caudal rings, a pronounced temporal streak, and a pale yellowish ventor, readily distinguished by colour and pattern from all other tree monitors. It is further distinguishable by the conical, not flat, gular scales, a more anterior nostril, and by a more robust appearance, especially the postocular region (Table 1).

DESCRIPTION

SVL 225–254mm. TL 450–513mm. Snout not depressed at tip. Nostril oval, slightly nearer tip of snout than eye. Six or seven transversely dilated supraoculars. Upper labials 21–23, uniformly coloured. Gular scales conical, pointed. Anterior nuchals round, smooth; anterior nuchals ovoid, slightly keeled, subequal with dorsals. Midbody scales in 90–93 rows. Ventrals in 84–91 rows, smooth. Adpressed limbs meet and overlap. Tail at least 1.75 times SVL, round in section, distinctly keeled.

In colour, *V. teriae* is black above, with a

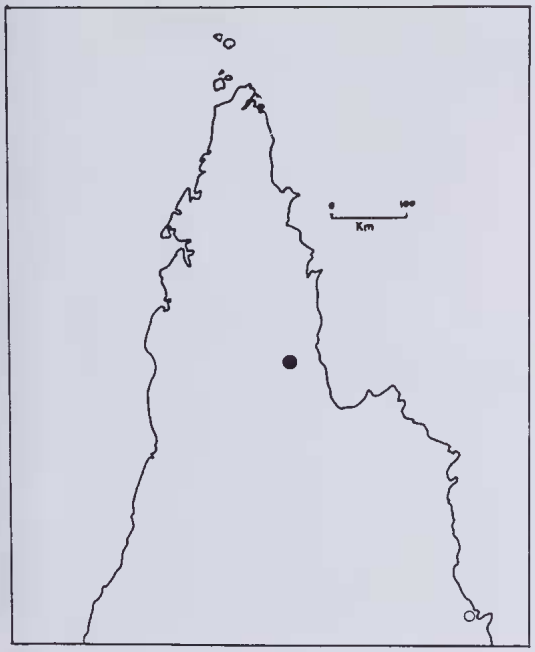

FIG. 7. Range map for *Varanus teriae* sp. nov. near Coen, Cape York Peninsula.

bluish-green upper snout, from tip to interorbital area. The body has small, yellow dots that form indistinct, paired chevrons that become caudal bands. A pale cream or yellow temporal streak extends from the posterior rim of the orbit 3–5 mm past the upper point of the ear, and is bordered above by a darker stripe. Ventral colouration is a pale lime green, including the ventral aspects of the limbs. The palmar surfaces are black, and covered with conical scales.

FIG. 8. *Varanus bogerti*, from Mertens (1950).

REMARKS

Colour, pattern, and the conical gulars separate *V. teriae* from other tree monitors. From *beccarii* it is further distinguished by its slightly keeled (vs strongly keeled) nuchals, smooth ventrals, higher ventral scale count (84–91 vs 70–79), and higher midbody scale count (90–93 vs 81–86). From *bogerti* it is distinguished by a higher snout (tip depressed in bogerti), shallower suture lines between cranial scales (giving *teriae* a smoother cranial texture) and slightly keeled nuchals (vs strongly keeled).

ETYMOLOGY

For my wife, Teri.

Varanus bogerti Mertens, 1950 comb. nov.

(Figs 5,8)

Varanus prasinus bogerti Mertens, 1950:3.
Varanus kordensis (Meyer); Boulenger, 1885:322. (part)
Varanus kordensis (Meyer); Boulenger, 1895:16.
Varanus kordensis (Meyer); DeRooij, 1915:152. (part)

MATERIAL EXAMINED

HOLOTYPE: AMNH41639, PARATYPES AMNH 41638, Fergusson Island, Milne Bay Province, Papua New Guinea; AMNH76722, Waikaiana, Normanby Island, Milne Bay Province, Papua New Guinea; BMNH76.7.6.2, South of Huon Gulf (Papua New Guinea); BMNH89.7.1.8, St Aignan, Louisiades, Milne Bay Province, Papua New Guinea.

DIAGNOSIS

A melanistic monitor lacking all trace of pattern. Tubercular, sharply keeled nuchals, rugose cranials and colour are distinctive. (Table 1).

DESCRIPTION

As given by Mertens (1950), except that nostril position in bogerti is not appreciably posterior to that of *beccarii*.

REMARKS

V. bogerti and *prasinus* come closer to sympatry than any other two members of the tree monitor group. *V. bogerti* is known from Fergusson and Normanby Islands, while *prasinus* is recorded for Goodenough (Burt and Burt, 1932; Mertens, 1950), all in the same archipelago.

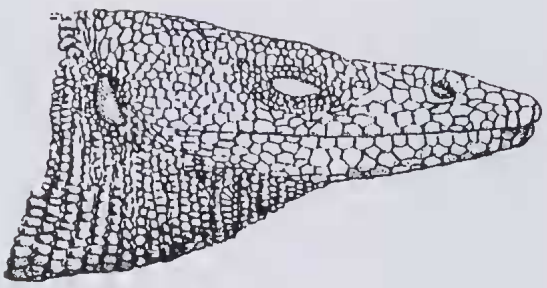

FIG. 9. *Varanus beccarii*, from type description of Doria (1874).

Varanus beccarii (Doria, 1874) comb. nov.

(Figs 3,9)

Monitor beccarii Doria, 1874:331.
Varanus kordensis(Meyer); Boulenger, 1885:322. (part)
Varanus kordensis(Meyer); DeRooij, 1915:152. (part)
Varanus prasinus beccarii Mertens, 1941:272.

MATERIAL EXAMINED

MCZ7489 (2 specimens), Aru Islands; BMNH1910.4.26.25-26, 'B.O.V. Expedition' Dutch New Guinea; BMNH1905.11.29.4, Fak Fak, Dutch New Guinea; one uncatalogued skull, plus 4 live specimens.

DIAGNOSIS

Melanistic, with triangular keeled nuchal scales. Differs from *bogerti* in having lower scale counts and smoother cranial lepidosis. It differs from *prasinus*, *telenesetes* and *teriae* in colour, pattern, and hull-shaped nuchal scales. (Table 1).

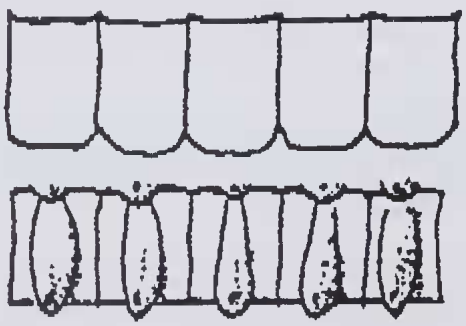

FIG. 10. Ventral scales of *Varanus salvator* (upper) and *V. varius* (lower), showing the two distinct morphologies of these scales in varanids.

DESCRIPTION

The largest of the tree monitors, to 340mm SVL; snout long, depressed at tip, considerably narrowed anterior to nostrils. Canthus somewhat distinct, giving the snout a higher appearance than in other tree monitors. Nostrils round, median between snout tip and anterior edge of orbit. Upper labials flat, smooth and distinct, 22–23 in number. Cranials large, polygonal and smooth, with minute pits. Sutures between cranials deep, giving a predominantly rough texture (less so than in *V. bogerti*). Supraoculars 3–7, transversely elongated. Scales from rictus to rictus 32–37. Nuchal scales are hull-shaped, keeled.

Dorsal scales elongate, moderately keeled, especially along the flanks. Midbody scales in 81–86 rows. Ventrals in 70–79 rows, slightly keeled, of *V. salvator*-like structure (Fig.10).

Adult SVL 150–340mm, TL 503–945mm.

Scales uniformly black, with no trace of pattern. Ventral surfaces also black, sometimes grayish near axilla and groin. The snout tip may be white in young specimens, from the rostral back three or four scales; in older specimens, this may become dark brown (preserved specimens). The head scales, especially the upper cranials and temporal scales, are glossy in texture.

REMARKS

The melanistic *Monitor beccarii* was described in 1874 (Doria, 1874) from Wokan, Aru Islands, south of western New Guinea. This species was distinguished on the basis of its black colouring and strongly keeled nuchal scales. The overall similarity in scale counts and morphology caused Boulenger (1885) to include it in his account of *V. kordensis*; similarly, DeRooij (1915) failed to separate *beccarii* from *kordensis* in her account. Mertens (1941) noted the affinities, including enlarged supraoculars, elongated limbs and body, tail round in section, overlapping ventral and midbody scale counts, and geographic proximity and assigned *beccarii* as a subspecies of *prasinus*.

DISCUSSION

A model for the *V. prasinus* group evolution can be presented. In tree monitors there is an elongation and narrowing of the snout beyond that seen in *V. indicus* and *V. salvator*. Limbs and

digits of tree monitors are longer and thinner than in *salvator*, though they resemble *salvator*. Three of the five tree monitor taxa are melanistic, (cf. the arboreal *V. rudicollis*, which in the adult stage is almost completely black). Insular melanism is seen in *salvator* from the Nicobar and Andaman Islands (Deraniyagala, 1944, 1961), but is rare in *Odatria* (*V. acanthurus insulanicus* [Worrell, 1963]; and *V. tristis*, which has a black head and body, and virtually indistinct rosette dorsal pattern [Cogger, 1975]) and the *gouldii* group (*V. rosenbergi* is characteristically dark, but retains a distinct pattern). Pattern in the *salvator*-related taxa involves small clusters of light scales that form indistinct circles and random spots, while in both the *V. gouldii* and *Odatria* groups, these patterns become well defined rings and flower-shaped spots. The green tree monitor falls into the former category. Even individuals with a spotted pattern more closely resemble the *salvator* or *indicus* pattern than they do either of the Australian groups.

Tail length in tree monitors exceeds 200% of SVL; in odatrians and *V. gouldii*, the tail tends to be shorter than 110% of SVL (exceptions are the odatrians *V. glebopalma, V. kingorum* and *V. pilbarensis*).

Nuchal lepidosis in *V. beccarii* and *V. bogerti* is similar to that of *V. rudicollis*, consisting of highly keeled, triangular scales that are distinct both in size and texture to surrounding scales. In the tree monitors, the scales are comparatively smaller than in *rudicollis*.

Ecologically, tree monitors are arboreal inhabitants of humid forests (Cogger, 1975; Czechura, 1980). This is similar to the *salvator* and *indicus* groups, but quite different from the terrestrial *gouldii* and *Odatria* groups, which tend to be found in xeric habitats (Cogger, 1975; Storr, 1980).

The evolution of tree monitors from *V. salvator* stock leading to the closely allied *V. indicus* stock would be a more parsimonious explanation of their evolutionary origin than the secondary dispersal from odatrians presented by Mertens (1942). The *V. indicus* group is unusual in that, along with *V. olivaceus*, it is the only non-prasinid with green pigmentation, though this is often so dark as to appear black. The colouration of *indicus* is quite similar to that of *teriae*.

In addition to the features described above, *Odatria* is characterised by round tails, with distinctly keeled to spinose lepidosis. The limbs tend to be short and stout, as are the digits. Ecologically, they inhabit xeric or marginally mesic areas (Mertens, 1942a,b; Worrell, 1963; Cogger, 1975; Storr, 1980). All these features suggest *Odatria* is derived from *gouldii*-group ancestors, not the other way around, as suggested by others (Mertens, 1942; Storr, 1964; King and King, 1975; Auffenberg, 1988). Consequently, for reasons of morphology, ecology, and distribution, prasinoids must be removed from *Odatria*.

ACKNOWLEDGEMENTS

I thank curators who allowed me access to specimens: Richard Zweifel, Walter Auffenberg, Ernst Williams, Wolfgang Bohme, William Duellman, George Zug, Jeannette Covacevich, Gregory Czechura, Darryl Frost, Harry Greene, Robert Drewes, Clarence McCoy, E. N. Arnold, and Hymen Marx. For discussions leading to clarification of ideas and procedures I thank Joseph Collins, Harry Greene, Jacques Gauthier, Samuel McDowell, Robert Hassur, and Vida Kenk. For access to live lizards, I am grateful to Ron Roper and Rudolf Maengkom. Wayne Savage and Serena Stanford arranged a grant from the Society of Archimedes, San Jose State University, for part of this research. Teri Sprackland contributed considerable amounts of time and money towards this research. Jacques Gauthier and Alan Leviton kindly provided work space and access to the PAUP computer program used for cladistic analyses. Jens Vindum, Robert Drewes and Harry Greene provided facilities during the study. This paper was submitted in partial fulfillment of the requirements for the degree of Master of Arts in Biology from San Jose State University.

LITERATURE CITED

ALLISON, A. 1982. Distribution and ecology of New Guinea lizards. Monographie Biologicae 42: 803–813.

AUFFENBERG, W. 1988. 'Gray's monitor lizard'. (Univ. Florida Press: Miami). 419p.

BOHME, W. 1988. Zur genitalmorphologie der sauria: funktionelle und stammesgeschichtliche aspekte. Bonner Zool. Monogr. 27: 1–176.

BOULENGER, G. 1885. 'Catologue of the lizards in the British Museum (Natural History), Vol. 2'.(British Museum (Nat. Hist.): London). 497p.

1895. On a collection of reptiles and batrachians from Ferguson Island, D'Entrecasteaux Group, British New Guinea. Ann. Mag. Nat. Hist. (6), 16:28–32.

BRANCH, W.R. 1982. Hemipeneal morphology of platynotan lizards. J. Herp. 16: 16–38.

BROWN, J.H. AND GIBSON, A.C. 1983 'Biogeography'. (Mosby:St. Louis). 643p.

BURT, C. AND BURT, M. 1932. Herpetological results of the Whitney South Sea expedition. VI. Pacific island amphibian and reptiles in the collection of the American Museum of Natural History. Bull. Amer. Mus. nat. Hist. 63: 461–595.

COGGER, H. 1975. 'Reptiles and amphibians of Australia'. 1st ed.(Reed:Sydney). 584p.

CZECHURA, G. 1980. The emerald monitor, *Varanus prasinus* (Schlegel): an addition to the Australian mainland herpetofauna. Mem. Qd Mus. 20: 103–109.

DERANIYAGALA, P. 1944. Four new races of the kabaragoya lizard, *Varanus salvator*. Spolia Zeylonica 24: 59–62.

1961. The water monitor of the Andaman islands - a distinct subspecies. Spolia Zeylonica 61: 78–85.

DeROOIJ, N. 1915. 'The reptiles of the Indo-Australian archipelago. I. Lacertilia, Chelonia, Emydosauria'. (E.J. Brill:Leiden). 384p.

DORIA, G. 1874. Enumerazione dei rettili raccolti dal Dott. G. Beccari in Amboina alle Isole Aru ed alle Isole Kei durante gli anni. Ann. Mus. Civ. Stor. Nat. Giacomo Doria 6: 325–357.

GRAY, J.E. 1831. A synopsis of species of the class Reptilia. 1–110. In Griffith, E. 'The Animal Kingdom arranged in conformity with its organization by Baron Cuvier, vol. 9'. (Whittaker, Treacher & Co:London). 481+110p.

GREENE, H. 1986. Diet and arboreality in the emerald monitor, *Varanus prasinus*, with comments on the study of adaptations. Fieldiana:Zool. 31:1–12.

HOLMES, R., KING, M. AND KING, D. 1975. Phenetic relationships among varanid lizards based upon comparative electrophoretic data and karyotypic analyses. Biochem. System. Ecol. 3: 257–262.

KING, M. AND KING, D. 1975. Chromosomal evolution in the lizard genus *Varanus* (Reptilia). Austr. J. Biol. Sci. 1975: 89–108.

LOSOS, J.B. AND GREENE, H.W. 1989. Ecological and evolutionary implications of diet in monitor lizards. Biol. J. Linn. Soc. 35: 379–407.

McDOWELL, S. AND BOGERT, C. 1954. The systematic position of *Lanthanotus* and the affinities of the anguinomorphan lizards. Bull. Amer. Mus. Nat. Hist. 105: 1–142.

MERTENS, R. 1941. Zwei neue Warane des australischen faunengebietes. Senckenbergiana 23: 266–272.

1942a. Die familie der Warane (Varanidae). Erster teil: allgemeines. Abh. Senck. Naturf. Ges. 462: 1–116.

1942b. Die familie der Warane (Varanidae). Zweiter teil: der schadel. Abh. Senck. Naturf. Ges. 465: 117–234.

1942c. Die familie der Warane (Varanidae). Dritter teil: taxonomie. Abh. Senck. Naturf. Ges. 466: 235–365.

1950. Notes on some Indo-Australian monitors (Sauria: Varanidae). Amer. Mus. Novitates 1456:1–7.

1959. Liste der Warane Asiens und der Indo-Australischen Inselwelt mit systematischen bemerkungen. Senck. Biol. 40: 221–240.

MEYER, A.B. 1874. Eine Mitteilung von Hrn. Dr. Adolf Bernhard Meyer über die von ihm auf Neu-Guinea den Inseln Jobi, Mysore und Mafoor im Jahr 1873 gesammelten Amphibien. Mber. K. Preuss. Akad. Wiss. Berl. 1874: 128–140.

MYERS, C. AND DALY, J. 1976. Preliminary evaluation of skin toxins and vocalizations in taxonomic and evolutionary studies of poison-dart frogs (Dendrobatidae). Bull. Amer. Mus. Nat. Hist. 157: 175–262.

PREGILL, G., GAUTHIER, J. AND GREENE, H. 1986. The evolution of helodermatid squamates with description of a new taxon and an overview of Varanoidea. Trans. San Diego Soc. Nat. Hist. 21: 167–202.

SCHLEGEL, H. 1839. 'Abbildungen neuer oder unvollständig bekannter Amphibien, nach der Natur der dem Leben entworfen'. (Arnz:Düsseldorf). 141p.

STORR, G. 1964. Some aspects of the geography of Australian reptiles. Senck. Biol. 45: 577–589.

1980. The monitor lizards (genus *Varanus* Merrem,1820) of Western Australia. Rec. West. Aust. Mus. 8:237–293.

WILEY, E. 1981. 'Phylogenetics, the theory and practice of phylogenetic systematics'. (John Wiley: New York). 439p.

WORRELL, E. 1963. 'Reptiles of Australia'. (Angus & Robertson: Sydney).207p.

APPENDIX 1. Character states for cladistic analysis of *Varanus*.

1. Nostril round (0) or slit-like (1).
2. Nostril posterior (0), median (1) or anterior (2) in position.
3. Nostril lateral (0) or dorsal (1).
4. Nostril region not swollen (0) or swollen (1) in appearance.
5. Nostril without (0) or with (1) a valve.
6. Nasal bones fused (0) or separate (1).
7. Closed mouth forms distinct seam (0) or is tight and seamless (1).
8. Tongue short (0) or long (1).
9. Tongue dark (0) or light (1) in color.10. Snout broad (0) or narrow (1) at tip.
11. Snout depressed (0) or high (1).12. Snout blunt (0) or acute (1) in adults.
13. Gular scales flat (0) or conical (1).
14. Eyelids with normal (0) or slightly fringed (1) scales.
15. Preocular streak present (0) or absent (1).
16. Postocular streak present (0) or absent (1).
17. Supratemporal arch thin (0) broad (1) or absent (2).
18. Supraocular scales subequal, small (0) or dilated, larger than interorbital scales (1).
19. Cranial scales flat, non-reflective (0) or glossy (1).
20. Cranial scales large, polygonal (0) or small, pebbled (1).
21. Cranial surface rough (0) or smooth (1).
22. Canthus rostralis rounded (0) or distinct (1).
23. Snout boxlike (0) or triangular (1) in section.
24. Nuchal scales subequal to dorsals (0) or larger than dorsals (1).
25. Nuchal scales rounded (0), keeled (1) or very keeled (2).
26. Nuchal area banded (0) or unbanded (1).
27. Nuchal scales smaller or equal to occipital scales (0) or larger than occipital scales (1).
28. Neck length moderate (0) or elongate (1).
29. Dorsal scales uniform, subequal (0) or heterogenous (1).
30. Dorsals small (0) or large (1).
31. Dorsum patterned (0) or unpatterned (1).
32. Digits with enlarged terminal scale (0) or not (1).
33. Claws conical (0) or compressed (1).
34. Ventral scales smooth (0) or keeled (1).
35. Ventral scales rectangular (0) or oblong (1).
36. Adpressed limbs meet (0) or do not meet (1).
37. Preanal pores absent (0) or present (1).
38. Ventral caudal scales larger or equal to dorsal caudals (0) or smaller than dorsal caudals (1).
39. Caudal scales irregular (0) or form bands of annuli (1).
40. Tail slightly (0) or fully (1) prehensile.
41. Caudal scales glossy, slightly keeled (0) or strongly keeled (1).
42. Tail length greater than (0), equal to (1) or less than (2) snout-vent length.
43. Tail round (0), approximately half round (1) or compressed (2) in section.
44. Tail lacking dorsal keel (0), or having double dorsal keel (1).
45. Tail banded (0) or unbanded (1).
46. Tail completely [100%] banded (0) or less than completely banded (1).
47. Parietal bone slightly (0) or greatly (1) constricted medially.
48. Gular fold absent (0) or present (1).
49. Ear exposed (0) or concealed (1).
50. Nasal bones dorsally with table-like surface (0) or knife-like (1).
51. Karyotype group A (0), B (1), C (2), D (3), E (4), or F (5) [data from Holmes, King & King, 1985].
52. Hemipenal group A (0), B (1), C (2), D (3), E (4), F (5), G (6) or H (7) [data from Bohme, 1986].
53. Reserved.
54. Size range 0.1-0.5 M (0), 0.6-0.9 M (1), 1-1.5 M (2), over 1.5 M (3).
55. Ventrally mottled (0) or solid (1) in color.
56. Ecology primarily fossorial/terrestrial (0), arboreal (1) or aquatic (2).
57. Palmar surfaces lacking (0) or possessing conical processes (1).
58. Palmar surfaces pale (0) or black (1).

APPENDIX 2. Distribution of characters in 23 varanid taxa. Unavailable data are entered by a '9'.

Taxon	Character state
GRISEUS	10010010000001000001010000000000000000000000011101429200 00
BENGALEN	10000001001000000000010000000000100010000021000101219300 00
EXANTHEM	10000001001000100000010100101100101100000111010101509310 00
SALVATOR	02000001010100000110010000110000110010000021000100249302 00
DUMERILI	11001001110100101010010100011100110010000021000100119212 00
RUDICOLL	10000001011100100100010120110000111000000021011101219201 01
PRASINUS	01010001010100100110101000010000110000110000100100139111 11
BECCARII	01010001010100100110001011010010110000110000100100139111 11
TELENESE	01010001010100100110101000010000100000110000100100139101 10
TERIAE	01010001010110100110001010010000100000110000000100139111 11
VARIUS	02000001100100000001010000110001111000000021001100169310 00
INDICUS	01010001010100110110001001110001100000000021000100139201 00
GOULDII	01010011110101000001010001010000100001000011010100069210 00
STORRI	02000110000101000001010001000001100100101100100100379010 00
BOGERTI	01010001010100000110001021010010100000110000100100139111 11
TIMOR	02000101100100000001000001010000100000100000000100379110 00
KOMODO	02000001100000110001000001000010110010000011101101169310 00
NILOTIC	11000001001000000001010000010000100010000021001101509300 00
OLIVAC	11010001101000100001000000010000100000000021001100299301 00
TRISTIS	02000101100000000000000000010000100000100000000100379010 00
FLAVES	11000001101000100000010000000000101010000011001101219200 00
PANOPTES	01010011111110100000101000101000010000100002100010069202 00
MERTENSI	02100011900000100010100001010000100000000021000100069212 01